

CLAIMS

Sub C1
1. A device or apparatus for manipulating matter in a confined or inaccessible space, comprising

(i) manipulator means at least partly constructed of one or more bent or twisted elongate shape memory alloy members having pseudoelasticity at the intended manipulation temperature, and

(ii) a hollow housing (preferably of elongate tubular form) or cannula capable of holding at least the shape memory alloy member(s) in a relatively straightened state, and

(iii) actuating means for extending the shape memory alloy member(s) from the housing to manipulate matter within the said space and for withdrawing the shape memory alloy member(s) into the housing, the arrangement being such that the shape-memory alloy member(s) bend(s) or twist(s) pseudoelastically in a lateral or helical sense to manipulate the matter on extending from the housing at the said manipulation temperature, and become(s) relatively straightened on withdrawal into the housing at the said temperature.

2. A device or apparatus according to claim 1 which is of elongate form for surgical manipulation of matter within a living body, and which has the manipulator means at its distal end with the shape memory alloy member(s) having pseudoelasticity at the temperature to be encountered within that body, and wherein the actuating means is operable from the proximal end of the device.

Sub C2
3. An apparatus for manipulating an object, said apparatus comprising:

a cannula having a longitudinal bore extending therethrough;

a member, disposed within said longitudinal bore and extendable therefrom, said member having, i) a proximal segment, and ii) a distal segment coupled to said proximal segment and at least partially constructed of an elastic material, said distal segment assuming a first shape when extended from said bore and assuming a second shape when withdrawn into said bore; and

a distal end structure, at a distal end of said member, for contacting said object to be manipulated.

4. An apparatus according to claim 3 for passing a ligature around an object, said apparatus comprising retainer means, located near a distal end of said distal segment of said member, for retaining a segment of said ligature during movement of said member into or out of said cannula, to pass said ligature around said object.
5. Apparatus according to claim 3, which is a surgical instrument comprising handle means, coupled to at least one of said cannula and said member, for manually inserting said member through said cannula to distally extend said distal segment from said bore, and for withdrawing said distal segment into said bore.
- Sub D2 → 6. An apparatus according to claim 3, wherein said distal segment is constructed at least partially of a pseudoelastic shape memory alloy, said distal segment assuming a first shape when extended from said bore and its alloy is in a substantially austenitic phase, and assuming a second shape when withdrawn into said bore and its alloy is stressed to contain more martensite phase.
7. Apparatus according to claim 3, wherein said proximal segment and said distal segment are of unitary construction.
8. Apparatus according to claims 3, wherein said distal end structure and said member are of unitary construction.
9. Apparatus according to claim 3, wherein said distal end structure has a substantially blunted shape, and has a lateral dimension substantially equal to a lateral dimension of said cannula, and is coupled to a distal end of said member such that a curved surface of said distal end structure is distal facing.
10. Apparatus according to Claim 9, wherein said distal end structure comprises a non-elastic structure separate from, and coupled to, said member.
11. Apparatus according to claim 3, wherein said distal end structure is a pointed tip of said distal end segment.
12. Apparatus according to claim 3 wherein said member is disposed within said cannula oriented such that said elastic distal segment exits said cannula in a predetermined lateral orientation, and the apparatus further comprises means for indicating said predetermined lateral orientation.

13. ~~Apparatus according to Claim 12, further comprising means for preventing said member from rotating within said cannula.~~
14. ~~Apparatus according to claim 4, wherein said retainer means comprises a hook formed into said member, either as a groove formed in said elastic distal segment, or plastically bent into said elastic distal segment.~~
15. ~~Apparatus according to claim 14, further comprising a post over which said ligature may be held in a doubled fashion, said post having a means for positioning said ligature for easy grasping of said ligature by said hook.~~
16. ~~Apparatus according to Claim 15, wherein said cannula further comprises means for temporarily holding a loop of said ligature substantially circumferentially about said cannula.~~
17. ~~Apparatus according to Claim 16, wherein said means for temporarily holding comprises a sliding sleeve, slideably mounted unto the distal end of said cannula such that said member may pass through said sliding sleeve.~~
18. ~~Apparatus according to Claim 4, wherein said cannula further comprises means for holding an end of said ligature to said cannula.~~
19. ~~Apparatus according to Claim 18, wherein said post includes a lateral protrusion over which said ligature may be held, to elevate said ligature from said cannula in order that said hook may more readily hook said ligature.~~
20. ~~Apparatus according to claim 18, wherein said means for holding an end moves sideways relative to the longitudinal dimension of said cannula when said member extends from said cannula.~~
21. ~~Apparatus according to claim 4, wherein said cannula further comprises grabber means for grabbing said ligature; and said first shape, which said distal segment assumes upon extension from said cannula, places said retainer means adjacent to said grabber means.~~
22. ~~Apparatus according to Claim 21, wherein said retainer means comprises an eye or groove near a distal end of said distal segment, adapted to retain said ligature during extension of said member from said cannula, and adapted such that said grabber means pulls said ligature out of said groove or through said eye upon retraction of said member.~~

23. An apparatus for inserting, through organic tissue, an elastic needle member having piercing and non-piercing end portions, said needle having a first shape when not subject to mechanical stress and a second shape when subject to mechanical stress, said needle returning toward said first shape upon at least partial relief of said mechanical stress, said needle having a transverse dimension, said apparatus comprising:

a longitudinally extending cannula having proximal and distal end portions and a bore extending longitudinally therethrough from said proximal end portion to said distal end portion;

a cannula insert having proximal and distal end portions, at least said distal end portion being disposed with said bore;

said distal end portion of said cannula insert having means for holding an end portion of said needle when said distal end portion of said cannula insert is within said bore, and for releasing said end portion of said needle when said distal end portion of said cannula insert extends distally out of said bore; and

said needle, when held within said bore, being mechanically stressed into said second shape, and said needle returning toward said first shape when extended from said bore.

24. Apparatus according to Claim 23, wherein said means for holding and releasing comprises a longitudinal needle delivery bore extending into said cannula insert at a distal end of said cannula insert; and said distal end portion of said cannula insert is formed of a compressible construction of a larger transverse dimension than said transverse dimension of said bore of said cannula, such that, i) when said distal end portion of said cannula insert is within said bore of said cannula, said needle delivery bore compresses to hold said end portion of said needle, and ii) when said distal end portion of said needle delivery member is extended out of said distal end portion of said cannula, said needle delivery bore expands to release said end portion of said needle.

25. Apparatus according to claim 24, wherein said distal end portion of said cannula insert is divided by one or more longitudinal slots into a plurality of end segments, said slots intersecting at said needle delivery bore, said slots each having a depth sufficient to allow the end segments to substantially approach each other when said distal end portion of said cannula insert compresses upon being disposed with said cannula.

26. Apparatus according to claim 24, wherein said needle delivery bore is radially removed in a first radial direction from said axis of said cannula insert, such that when said

needle is held in said apparatus in an orientation so as to curve across said needle delivery bore generally away from said first radial direction, said needle is subjected to reduced strain, being stressed into a third shape whose straightness is between that of said first and second shapes.

27. Apparatus according to claim 24, wherein said cannula may be distally re-extended onto said distal end portion of said cannula insert to recompress said delivery bore and cause it to grip either end portion of said needle within said delivery bore for full or partial retraction of said needle into said cannula.

28. Apparatus according to claim 23, further comprising means for signalling release of said needle from said means for holding, wherein said means for signalling further comprises a raised tab extending radially outward from said distal end portion of said cannula insert farther than a segment of said cannula insert which lies axially directly proximal from said tab, said tab having a transverse dimension such that said tab is disposed within said cannula under stress, so that during extension of said cannula insert beyond said distal end portion of said cannula, said stress is relieved over a short distance of axial movement as said tab exits said cannula and said segment begins to extend beyond said cannula, to produce a tangibly or audibly detectable signal.

29. Apparatus according to claim 23, further comprising means for feeding a suture to said needle during suturing, wherein said means for feeding comprises (i) a suture feed bore defined by and extending longitudinally through said cannula insert, said suture feed bore including said needle delivery bore and extending to said distal and proximal ends of said cannula insert, such that a length of suture may be pulled therethrough during suturing, and (ii) a bobbin within said cannula insert, from which suture may be pulled through said feed bore.

30. Apparatus according to claim 23, wherein said needle is released from said cannula insert in a predetermined orientation of curvature substantially perpendicular to an axis of said apparatus, and said apparatus further comprises means for indicating the direction of said predetermined orientation.

31. A surgical instrument apparatus comprising a ring clip elastic member which, i) has a piercing end portion and a non-piercing end portion and a transverse wire dimension, ii) has a first shape when not subject to mechanical stress, iii) has a second shape when subject to mechanical stress, and iv) returns toward said first shape upon at least partial relief of said mechanical stress; a cylinder which has, i) a proximal end portion and a distal end portion, and ii) an inside dimension not smaller than said transverse wire dimension of said ring clip, such

that a substantially straightened ring clip may be disposed within said cylinder; and a piston which has, i) a proximal end portion and a distal end portion, and ii) an outer dimension slightly smaller than the inside dimension of said cylinder, such that said piston may be disposed with said cylinder proximal to said ring clip and may be inserted through said cylinder to extrude said ring clip out of said cylinder.

32. Apparatus according to claim 31, further comprising means for containing a plurality of rings clips and for allowing their extrusion one at a time.

33. Apparatus according to Claim 32, wherein said means for containing either comprises said cylinder and piston being of sufficient length such that said plurality of ring clips may be disposed within said cylinder in a linear, coaxial manner for serial extrusion, or comprises a magazine, coupled to and extending into said cylinder, for holding said plurality of ring clips, said magazine including spring means for maintaining stress upon said ring clips to keep said ring clips substantially straight, and being adapted to introduce a next ring clip into said cylinder after a previous ring clip has been extruded and said piston retracted.

34. Apparatus according to Claim 33, further comprising piston spring means for compressing upon insertion of said piston through said cylinder to expand upon release of said piston, to retract said piston from said cylinder far enough to remove said piston from said magazine in order to allow said magazine to introduce said next ring clip into said cylinder.

35. Apparatus according to claim 31, operable as a handheld instrument for inserting said elastic member into organic tissue said apparatus comprising a cylindrical second member, coaxially disposable within said cannula and rotatable therewithin, and having a spool around which said elastic member may be wound under stress to a reside within said first member, said spool being positioned near said distal end of said second member to align with said aperture when said second member is disposed within said first member; and means for rotating said second member within said first member to unwind said elastic member from said spool through said aperture.

36. Apparatus according to Claim 34, wherein said means for rotating said second member comprises a plunger which is coaxially disposable within said first member and within said second member is coaxially disposable; one of said plunger and said second member having at least one longitudinal, spiral groove; the other of said plunger and said second member having a groove engaging structure which extends radially between said plunger and said second member and into said at least one spiral groove; and means for pressing said plunger distally onto said second member to impact coaxial rotation to said second member to

turn said spool within said first member, to unwind said elastic member from said spool through said aperture.

Sub 3
37. A surgical device comprising

(a) a housing; and

(b) a barrier member, the barrier member comprising an elastically deformable loop, and a barrier membrane loosely spanning the loop; wherein the barrier member is moveable between a first position wherein the barrier member is constrained within the housing, and a second position wherein the barrier member is unconstrained by the housing and assumes an expanded memory shape.

38. A device according to Claim 37 which comprises an endoscopic device, or a laparoscopic device, or which is deployed from within an instrument channel of a laparoscopic device, or wherein the barrier member provides an internal surgical drape, or a tissue collection pouch, the tissue collection pouch preferably including a mouth portion which can be substantially closed.

39. A device according to claim 37 further comprising a cautery device, preferably of elastic material.

Sub 4
40. A cautery device comprising

(a) a housing; and

(b) a shape memory alloy cautery wire; wherein the cautery wire is moveable between a first position wherein the cautery wire is constrained within the housing, and a second position wherein the cautery wire is unconstrained by the housing and assumes an expanded memory shape.

41. A device according to Claim 40 wherein the said loop is formed by two arms whose distal ends approach, but are not fixed to, each other, and the arms can be withdrawn into the housing independently of the barrier member.

Sub 4 1/2
42. A device according to Claim 41, wherein drawstring means are provided for withdrawing the barrier member.

43. A device according to Claim 42, wherein the housing and the loop can be separated from the barrier member and drawstring means in use.

Sub 25 → 44. A remotely operated surgical device comprising

- (a) an elongate housing;
- (b) a surgical screen comprising elastic material;
- (c) means for projecting and retracting the surgical screen between a first position wherein the surgical screen is constrained within the housing, and a second position wherein the surgical screen is deployed from the housing and assumes an expanded shape.

Sub 26 → 45. A device according to Claim 44 which comprises an endoscopic device a catheter, or a laparoscopic device.

Sub 26 → 46. A device according to Claim 44 wherein the surgical screen comprises at least one loop, preferably a graduated series of a loops.

47. A device according to Claim 46 wherein the surgical screen comprises at least one loop which is spanned by a perforated sheet, or the surgical screen comprises at least two loops, the area between the loops being spanned by a perforated sheet.

48. A collapsible surgical stone basket of the type expandably deployable from a sheath, the basket consisting mainly of a shape memory alloy.

49. A medical retriever device for the removal of an internal obstruction, comprising an elongated, narrow sheath housing; and a basket of relatively large diameter extendible from the distal end of said sheath, said basket defined by a multiplicity of spaced apart, outwardly bowed arms which extend radially away from the axis of said sheath and are joined at each of the distal and proximal ends, the outwardly bowed basket arms comprising a pseudoelastic shape memory alloy; and remote means to project, retract and rotate said basket relative to the distal end of the sheath.

Sub 27 → 50. A remotely operated surgical device comprising

- (a) an elongate housing
- (b) a retractor, the retractor comprising at least one elastically deformable loop; and

(c) means for projecting and retracting the retractor relative to the housing between a first position wherein the retractor is constrained within the housing, and a second position wherein the retractor is unconstrained by the housing and assumes an expanded memory shape.

Sub 811 → 51. A device according to Claim 50 which comprises an endoscopic device, a catheter, or a laparoscopic device.

52. A device according to Claim 50 wherein the retractor comprises at least one loop which is spanned by a membrane, or wherein at least one membrane spans an area between two loops, or wherein the retractor comprises at least one finger-shaped member (preferably spanned by a membrane), or wherein a membrane spans an area between two finger-shaped members.

53. A remotely operated surgical device comprising

(a) a substantially linear housing having a distal deployment opening;

(b) a curved elastic blade which is constrainable in a relatively straightened shape within the housing; and

(c) remote means to project and retract the elastic blade relative to the distal deployment opening between a first position wherein the elastic blade is constrained in a relatively straightened shape within the housing, and a second position wherein the elastic blade is not constrained by the housing and assumes a relatively curved shape.

54. A device according to Claim 53 which comprises an endoscopic device, a catheter, or a laparoscopic device.

55. A device according to Claim 53 wherein the elastic blade comprises at least one cutting edge, preferably of a material which is different from that of the elastic blade.

56. An instrument device comprising

(a) a distal bladed element having a first pivoted blade, and a second opposing blade;

(b) an elastically deformable stem connected to the bladed element;

- (c) a proximal blade actuator means for causing pivotal motion of the pivotable blade; and
- (d) a stem deformation control means for controlling the deformation of the elastically deformable stem.

57. A device according to Claim 56 wherein the elastically deformable stem comprises an elastic member which is substantially straight when it is constrained, and assumes a bent or curved shape when it is unconstrained; and the stem deformation control means comprises a longitudinally slidable substantially straight constraining member.

58. A device according to Claim 56 further comprising an elongate housing, preferably a flexible polymeric tube, and preferably further comprising a constraining rod.

59. A device according to Claim 56, comprising an elongate housing (preferably a rigid elongate tube) and the elastic member is moveable between a first position wherein the elastic member is constrained within the housing, and a second position wherein the elastic member is deployed from the housing and assumes an unconstrained shape.

60. A device according to Claims 56, wherein at least one of the first blade and the second blade includes a grasping surface which can be used to grasp an object, or wherein at least one of the first blade and the second blade includes a cutting edge which can be used to cut an object.

61. A device according to Claim 56, wherein the first blade is moveable between a closed position wherein the axes of the blades are substantially parallel, and an open position, wherein the axes of the blades are deflected from the parallel.

62. A device according to Claim 56 in which at least the bladed element is readily removable from the device and is replaceable, preferably as a unit wherein said bladed element is capable of integrating with the blade actuator means, and the elastically deformable stem is capable of integrating with the stem deformation control means.

63. A device or apparatus according to claim 3 wherein the elastically deformable member(s) is (are) composed of pseudoelastic material, or of shape memory alloy, which is preferably pseudoelastic, more preferably superelastic, under the intended conditions of use.

CS
Sub 98

Sub D 12 → 64. A device or apparatus according to a claim 3, wherein the elastic member(s) is (are) composed of nickel-titanium shape memory alloy, preferably capable of more than 1.5%, more preferably more than 4%, elastic deformation.

Sub D 9 → 65. A device or apparatus according to claim 3, wherein the elastic member(s) is (are) composed of shape memory alloy which assumes a first shape in a substantially austenitic phase when extended from the housing or cannula, and assumes a second shape containing more martensitic phase when withdrawn into the housing or cannula.

Sub D 13 → 66. A device or apparatus according to claim 3 including means for indicating the orientation of the elastically deformable member(s) when extended from the housing or cannula.

67. A device or apparatus according to claim 3, including means for preventing the elastically deformable member(s) from rotating within the housing or cannula.

Sub D 14 → 68. A device or apparatus according to claim 3 suitable for use as a surgical instrument.

add 9/10

add B1

add 2/6